THE DENTITION OF THE MAORI DOG OF NEW ZEALAND

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Abstract. Cranial and dental characteristics of the Polynesian dog of New Zealand are defined. Pathological and congenital abnormalities are discussed, and the study is shown to be relevant to wider problems of New Zealand prehistory.

The material in this paper is based on an analysis of the dentition of 389 mandibles and 204 crania from a total of 90 sites, ranging from Stewart Island in the extreme south of New Zealand, to Tom Bowling Bay at the extreme north of the North Island (Figs. 1-2). The study was undertaken with two major aims in view: firstly to define and describe physical features of the now extinct Polynesian dog of New Zealand; and secondly to relate the data to more general archaeological problems. Since the dog, the only domesticated animal of the Maori, lived in close association with man throughout New Zealand prehistory, changes in its dentition and skeletal characteristics over time and space could be expected to give valuable indirect evidence on greater changes in Maori economy as a whole.

Abnormalities, both congenital and pathological, were carefully noted; the former because of the possible significance of their distribution over space and time, the latter for the information they might give on the age, diet, and general condition of the Maori dog.

An important point was possible variation over space or time. Although obviously the location of all skeletal material was known, it was found to be impossible to place most of the skeletal material in chronological order. Even in the few sites with radiocarbon dates (10 out of 90 sites, or 11%), skeletal material had usually not been collected according to layer. Since nearly all the sites had multiple occupation layers, covering up to 500 years[1], any time control had been lost.

Sites were therefore simply classified as North or South Island Archaic or Classic, wherever this was possible. A site was considered to be Archaic if it contained moa bones or Archaic artifacts, Classic if it contained artifacts typical of the Classic Phase. Twenty percent of the sites had no associated artifacts and could not therefore be assigned to either category, but these contained only 7% of the minimum number of dogs, and 3% of the total number of bones. Usually skeletal remains from this type of site consisted of a single cranium or mandible, which were nearly always surface finds.

[1] e.g. Pounawea, with dates ranging from 1140 ± 60 A.D. to 1660 ± 60 A.D.

Rec. Auckland Inst. Mus. 8: 29-45 December 17th 1971

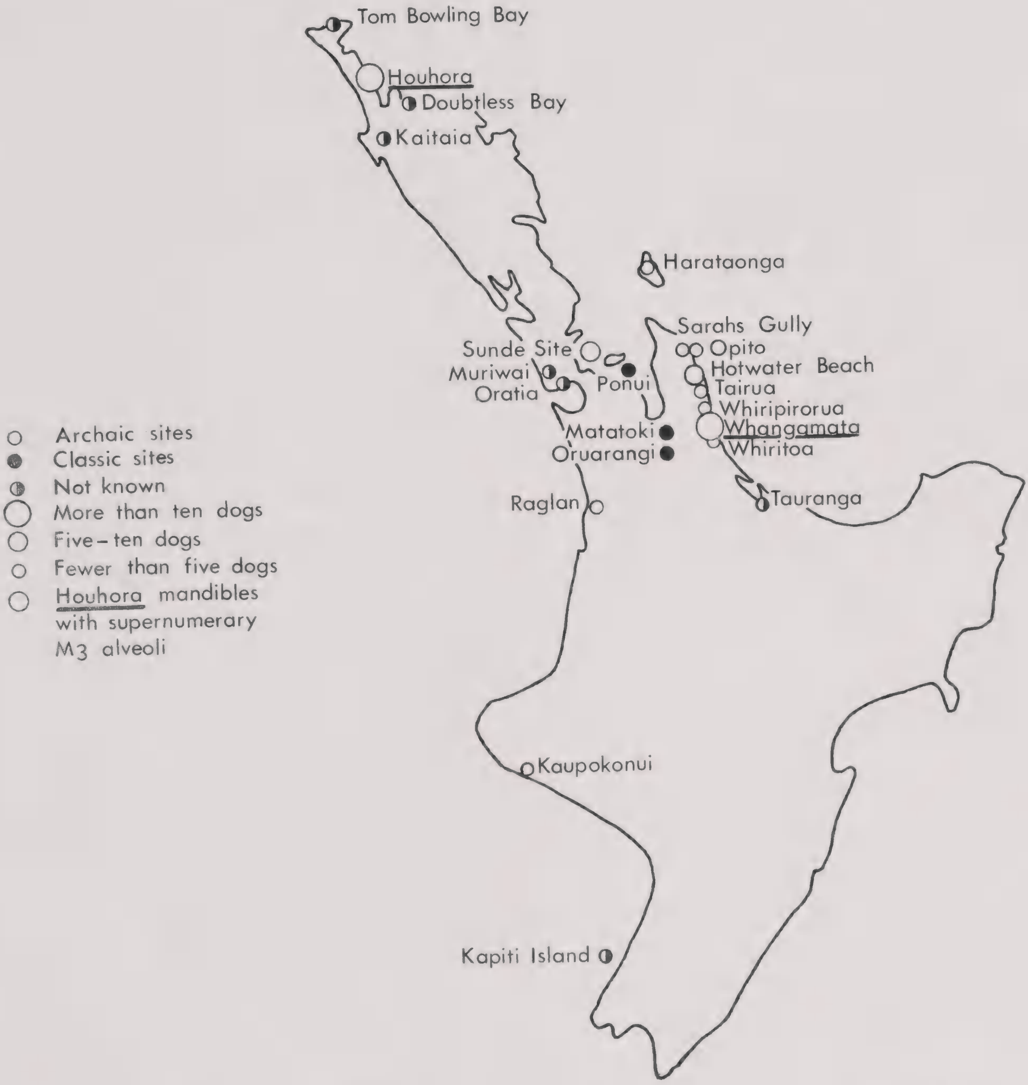

Fig. 1. Distribution of dog skeletal material studied from the North Island.

The majority of the skeletal material, then, did have cultural associations, and could thus be related to broader problems in New Zealand prehistory, as well as defining on an objective basis the Maori dog, known previously only by scattered and somewhat contradictory ethnographic descriptions (e.g. Colenso 1878; Forster 1777, p. 219; Crozet 1891; Dieffenbach 1843).

Skeletal Characteristics

It is of obvious interest to define characteristics by which Maori dog skeletal remains, often found without artifactual associations, can be distinguished from introduced European breeds. Although it was not possible to establish any feature common to all Maori dogs and unique to them, there were found to be a number

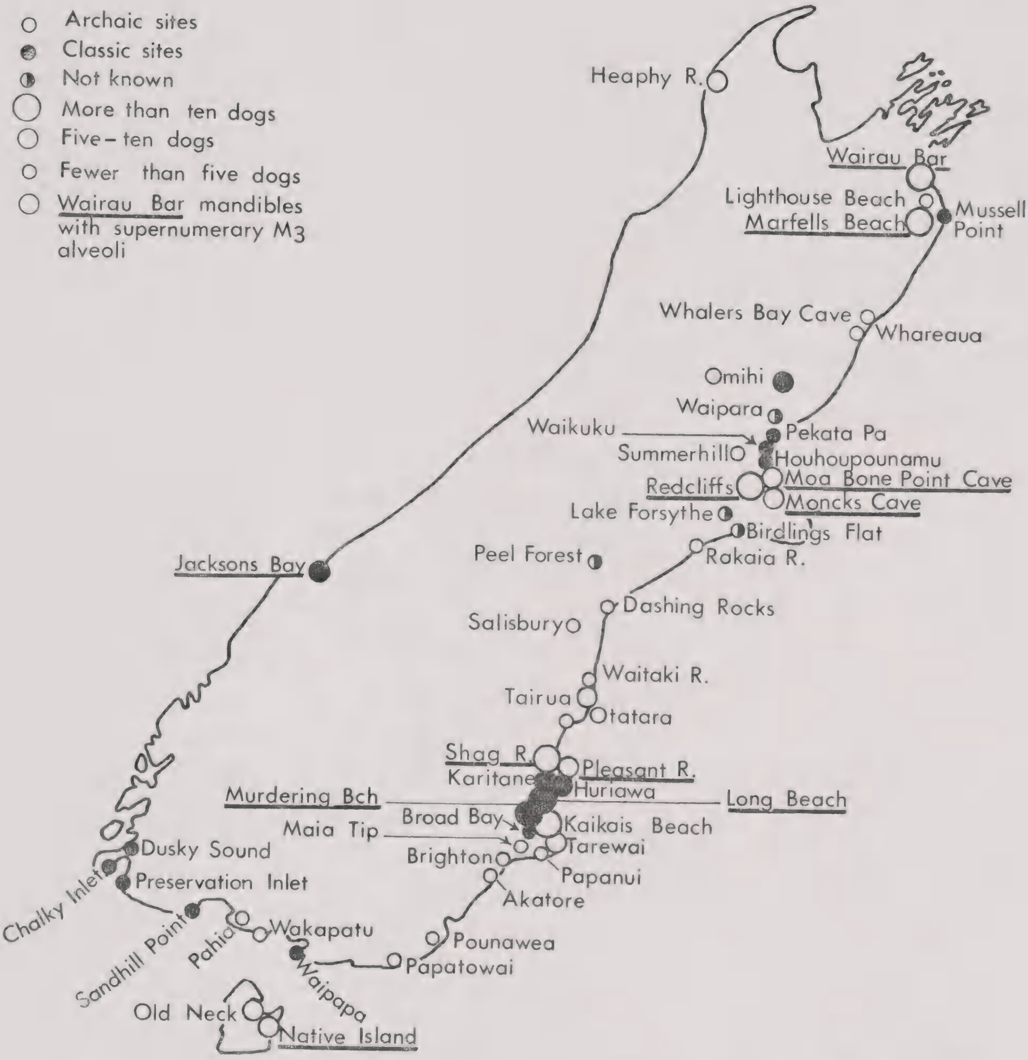

Fig. 2. Distribution of dog skeletal material studied from the South Island.

of characteristics which occur singly in many European breeds, but which are unlikely to occur together in any but a New Zealand Polynesian dog. Four of these may be established by direct observation.

Firstly, the sagittal crest is prominent. This was an almost universal feature of the Maori dog and was observed in 106 out of 110 crania or 96%[1]. However, four adult crania were found with a reduced sagittal crest, giving the back of the skull a rounded, juvenile appearance. Two of these, from Hawkes Bay and Matatoki, were surface finds, and a third comes from a site (Oruarangi) with early

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[1] A large proportion of the crania lacked the posterior part, which had been removed for the extraction of the brain. The number of crania above is not the total number present in the skeletal material, but the number where the sagittal crest was present for observation.

European material; they may therefore be European dogs, or of mixed Maori-European breed. The fourth comes from a South Island Archaic site (Shag River), but its archaeological associations are unknown, and it may belong to a European breed. This cranium is unusual in other respects (see below p. 34) and, if prehistoric, may be congenitally abnormal.

The presence of a prominent sagittal crest, although characteristic of the Maori dog, is of course not unique to it, being found in any breed of dog with massive jaws and powerful jaw musculature. It is interesting to note that the features does not seem to be present in the Polynesian dogs of the Pacific Islands, which ate mainly a soft vegetable diet.

The skull of the Tahitian dog is described by Luomala (MS.) as "slender and delicate in appearance", implying a small sagittal crest, although this is not specifically mentioned.

Wood-Jones, in describing skulls of the Hawaiian native dog, stated that, consequent to a diet of soft vegetable matter, the skulls became shorter, rounder, and devoid of sagittal crests (Wood-Jones 1931). Thus the prominent sagittal crest of the Maori dog would seem to indicate a diet of hard matter, certainly bones, and possibly fern-root (Allo 1970, pp. 189-191).

Another characteristic of the cranium of the Maori dog is the situation of the posterior end of the nasal bone. It ends in a relatively anterior position, level with the posterior borders of the premaxillas (Fig. 3). In contrast, the nasals of all

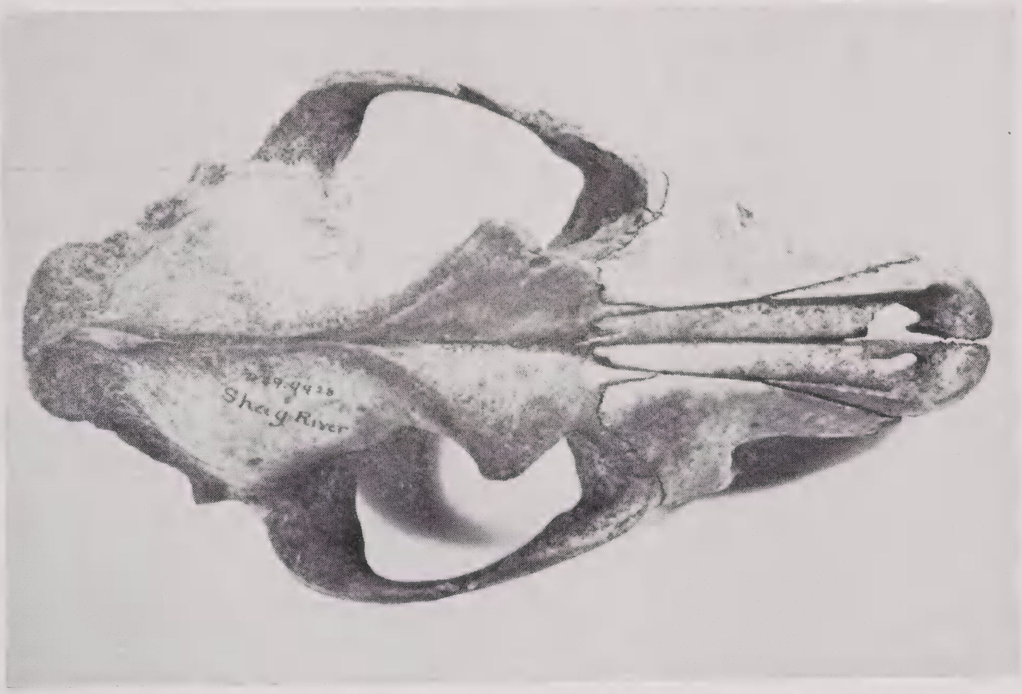

Fig. 3. Cranium from Shag River, South Island. Note position of nasal bone and pronounced sagittal crest.

observed modern breeds, both brachycephalic and dolichocephalic, end some distance behind the maxillas. This feature of the position of the nasal bone may have continued for a time in Maori-European crosses, or may be present in unobserved modern breeds, since it is also found in the Hawkes Bay, Oruarangi and Matatoki specimens mentioned above.

A third easily distinguishable feature in the crania of at least some Maori dogs is the presence of supernumerary alveoli, representing either additional teeth, or the double roots of a normally single-rooted tooth. These alveoli are usually found behind the third molar of the mandible, although sometimes they are also present between the first premolar and the canine and, more rarely, between the third and fourth premolars.

The Maori dog, as indicated below, had a dolichocephalic skull, and a very long muzzle in relation to the length of the brain-case, but this is not accompanied in European breeds by additional teeth. In his study of modern dog dentition, Crawford (1937, p. 216[1]) wrote:

> In the dolichocephalic breeds it might be expected that there would be more supernumerary teeth because of the greater length of the jaws. This has not been the case in our observations. Rather the teeth are more widely spaced with exposed gums between, especially in the premolars. The dental formula for this type apparently runs true to form.

It must be emphasised that the characteristic of additional alveoli is not a normal feature of Maori dog dentition — it was found in less than 1% of South Island mandibles — but where it is found on a site it is fairly common. It was found in 30% of the Wairau Bar mandibles, for example. The interesting question of its spatial distribution will be discussed later: here it is sufficient to note that where supernumerary alveoli are seen in a dog mandible or cranium from a New Zealand site, it is likely to be that of a Maori dog.

Fourthly, the teeth of the Maori dog are well spaced in a long narrow tooth row. Tooth crowding was very rare, being found only in one mandible (0.2% of total) and three crania (1.5% of total).

The index for tooth crowding proposed by Degerbøl (1961, p.31), whereby the combined lengths of the premolars are compared to the distance from the posterior edge of the alveolus of the canine to the anterior border of the alveolus of the carnassial, was applied to the crania from Wairau Bar, Houhora, and Whangamata. (A high figure from this indicates pronounced crowding of the teeth, while a low index indicates the opposite). Results for the crania measured were uniformly low, ranging from 75-81 (similar to the indices of free-ranging wolves, who also are characterised by a long facial region with diastema between the premolars). This is not a unique characteristic of the Maori dog, however, since tooth crowding is rare in European domesticates (except, of course, in brachycephalic and a few mesaticephalic breeds).

Finally, there are two indexes to aid identification of a cranium found in a New Zealand site as that of a Maori dog.

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[1] But cf. Sisson 1962, p. 502.

The cephalic index measures the relationship of head length to head width. The head length is usually considered to be the distance from the nuchal crest to the anterior end of the premaxillary suture; head width is the distance between the summits of the two zygomatic arches. The formula for the cephalic index is as follows:—

$$\text{Cephalic Index} = \frac{\text{Width x 100}}{\text{Length}}$$

An extreme dolichocephalic breed, such as the greyhound, will have a cephalic index of about 50. At the other extreme is the brachycephalic pug or bull-dog with a cephalic index of about 90. Examples of mesaticephalic breeds, with a cranial index of about 70, are the fox terrier and the great dane.

A certain difficulty was experienced in establishing the average cephalic index of the Maori dog, since the combination of intact brain-case (in nearly all the crania the occiput had been detached for the extraction of the brain) and intact zygomatic arches was comparatively rare (only 6% of skulls were suitable). The cephalic index of these crania is shown in Table 1.

Table 1. Cephalic index of the Maori dog.

SITE	Cranial Width (cm)	Cranial Length (cm)	CEPHALIC INDEX
Archaic South			
Shag River	10.60	16.86	63
Shag River	10.20	18.85	54
Wairau Bar	9.75	17.65	55
Kaikais Beach[1]	7.07	13.35	53
Moa Bone Point Cave	8.55	16.72	51
Moa Bone Point Cave[2]	5.68	9.55	59
Classic South			
Karitane	9.60	17.50	55
Waipapa	8.78	15.45	57
Archaic North			
Houhora (surface find)	8.30	14.72	56
Classic North			
Matatoki	9.09	16.00	57
Oruarangi	9.08	16.46	55

[1] Juvenile, aged *c.* 7 months [2] Juvenile, aged *c.* 5-6 months

It can be seen that, although the dimensions of adult crania from different sites vary widely, the cephalic index remains relatively constant. All crania are dolichocephalic (except the Shag River cranium mentioned above) with an average cephalic index of 55, and all fall within four points of this figure. It can be accepted, then, that the Maori dog had a relatively long narrow skull, slightly broader than that of the modern greyhound.

The cranio-facial index, used to describe the shape of the face (i.e. the relative proportions of muzzle and brain-case), was also applied. This index is expressed in terms of the ratio of the distance between the nuchal crest and the fronto-nasal suture to the length of the nasal bone. Results are shown in Table 2.

Table 2. Cranio-facial index of the Maori dog.

SITE	Occiput to Nasion (cm)	Nasal Length (cm)	CRANIO-FACIAL INDEX
Archaic South			
Kaikais Beach[1]	7.53	6.08	10:8
Marfells Beach	8.55	6.93	10:8
Moa Bone Point Cave	9.02	7.78	10:8.5
Moa Bone Point Cave[2]	6.06	3.96	10:6.5
Moncks Cave	8.97	7.60	10:8
Old Neck	10.55	9.10	10:8.5
Shag River	10.46	8.65	10:8
Shag River[3]	10.60	7.57	10:7
Shag River	10.20	8.75	10:8.5
Tarewai[4]	7.48	5.46	10:7
Wairau Bar	9.14	7.55	10:8
Wairau Bar	9.81	8.18	10:8

[1] Juvenile, aged *c.* 7 months

[2] Juvenile, aged *c.* 5 months, comparatively short muzzle, crowded teeth

[3] Cranium with reduced sagittal crest, brachycephalic skull, mentioned in text

[4] Juvenile, aged *c.* 7 months

In every case there was an exceptionally high cranio-facial index, i.e. the snout was very long compared to the length of the brain-case. The cranio-facial index tends to increase with length of head. That of the greyhound, an extremely dolichocephalic breed, is only 10:7; that of the pug is 10:3. The very high cranio-facial index of the Maori dog is even more remarkable considering the characteristic anterior position of the posterior end of its nasal bone.

A long muzzle in the dog is usually associated with heavy jaw musculature and a powerful bite, hence with a diet of resistant matter requiring much crushing and grinding. It is interesting to compare the long narrow snout of the Maori dog with that of the Hawaiian dog, described as short and rounded with a short broad palate (Wood-Jones 1931). This dissimilarity is almost certainly due to dietary differences.

To summarise, the cranial and dental characteristics of the Maori dog are as follows: prominent sagittal crest; narrow skull with a very long muzzle in relation to the length of the brain-case; well spaced teeth; occasional supernumerary alveoli; and the nasal bone typically ending level with the posterior borders of the maxillas[1].

Each of these skeletal characteristics is not enough in itself to distinguish a European from a Maori dog, since each feature (with the possible exception of the position of the posterior end of the nasal bone and the supernumerary alveoli) is also found in various European breeds. They are, however, most unlikely to occur together in any but a Polynesian Maori dog. Obviously, identification of a specimen from an archaeological site as a Maori dog will increase in accuracy with the number of features available to be observed and measured.

[1] There are also characteristic features in the body skeleton, such as the long narrow glenoid fossa of the scapula, and short legs in relation to body size. See Allo 1970, chapter III.

Dogs of tropical Polynesia showed marked differences in skull and jaw formation, due to a soft vegetable diet. No dogs of this kind have been found in New Zealand, but presumably they existed, since the Maori came (with dogs) from this area. There is no way of telling how quickly the Polynesian dog in New Zealand responded physically to a new diet and environment, but certainly at least one generation would have had the broad palate and rounded skull typical of the tropical Polynesian dog. If such dogs were found on a New Zealand site, it would be strong presumptive evidence that the site represented one of the first New Zealand settlements.

Pathological and Congenital Abnormalities

PATHOLOGICAL ABNORMALITIES

Pathological abnormalities, i.e. those acquired after birth as a result of disease or trauma, were fairly common in the dentition of the Maori dog, and gave valuable information on the diet and general condition of the Maori dog.

Frequently mandibles and crania were observed with recession of the alveolar bone due to periodontal disease. This recession was sometimes accompanied by tooth loss and subsequent ossification of the empty alveolus.

Periodontal disease, an infection of the soft tissues of the mouth and subsequently of the alveolar bones, may be caused by attrition, irritation by tartar deposits, poor diet resulting in lowered tissue resistance, or sometimes irritation from a faulty or damaged tooth (see e.g. Brothwell 1963, pp. 147-149).

Table 3 gives the incidence of periodontal disease in the various sites, showing the jaws and teeth affected, the degree of tooth wear (see p. 37), the degree of alveolar recession, and the cause (where known).

Table 3. Periodical disease in the Maori dog.

SITE	JAW	TOOTH WEAR	TOOTH AFFECTED	DEGREE OF PERIODONTAL DISEASE	PROBABLE CAUSE
Archaic South					
Kaikais Beach	R. Mandible	*	P_3, P_4, M_1	Medium	Possible attrition
Little Papanui	R. Upper	3.5	P^4	Slight	
Moa Bone Pt. Cave	R. Mandible	*	P_2, P_3	Considerable	
Pleasant River	L. Mandible	2	Canine	Slight	
Shag River	L. Mandible	*	P_4	Considerable	
Wairau Bar	L. Mandible	1	P_3, P_4	Slight	
Classic South					
Huriawa	R. Upper	3.5	P^4	Slight	Possible attrition
Karitane	L. Upper	4	P^3	Slight	Attrition
Long Beach	R. Mandible	*	P_4, M_1	Slight	Irritation from congenital deformity[1]
Murdering Beach	L. Upper	*	P^3	Slight	

* Teeth fallen out after death

[1] Congenital deformity of dentition: only 2 premolars (no P_1, P_2), P_4 has two fused roots in a single alveolus

It can be seen that there is a higher rate of periodontal disease in the lower than in the upper jaws, and that it is not known in North Island sites. The fact that periodontal disease was not found at either Houhora or Whangamata, with a total of 94 mandibles, may imply that some factor causing alveolar infection was present only in the South Island. This factor may be diet: either the South Island dogs may have had a lower nutritional intake, leading to diminished tissue resistance, or their diet may have consisted of a higher proportion of resistant matter, such as bones, resulting in accelerated dental attrition, one of the causes of periodontal disease.

An examination of tooth wear in the Maori dog would seem to support the latter explanation. Obviously the rate of tooth wear in a dog would be affected by its diet. It would be expected that the teeth of an animal eating a hard resistant diet would wear more quickly than those of animals living off softer foods.

The teeth of each jaw studied were given a rating on a scale from one to five (to half a point). The rating was as follows.

1. Some abrasion on inner surface of carnassials, but very little. Incisors still have the "fleur de lys" shape.

2. Cusps on carnassials and first and second molars show signs of wear. "Fleur de lys" shape begins to disappear.

3. Carnassials very worn, partial disappearance of lingual cusps on upper first molar. Canine shows signs of wear, disappearance of "fleur de lys" shape of incisors. (In European dogs this takes place at approximately two years).

4. Cusps worn flat on second molar (also third molar in lower jaw), also posterior cusps of lower carnassial. Extensive wear on crowns of incisors, pre-molars.

5. Incisors worn almost flat to original gum surface, wear on canine gives spatulate flat top to crown. Inner surface of carnassials and molars worn smooth and concave. Large anterior cusps of carnassials worn completely away. (In a European dog, eating processed foods, the last stage of wear would indicate extreme old age. The same is not necessarily true of the Maori dog).

Results of application of this scale are shown in Table 4.

It is evident that the pattern of extreme tooth wear is found only in South Island sites. If the average age at death of the dogs from North and South Island sites was the same, these results would seem to indicate conclusively that North Island dogs did live off a softer vegetable diet, but since tooth wear is a product of age as well as diet, the high frequency of advanced tooth wear in, for example, the South Island Classic sites of Long Beach and Murdering Beach, may also imply a higher proportion of aged dogs. This is also suggested by other evidence (Allo 1970, pp. 117-130). It is unlikely, however, that there were no aged dogs in the North Island sample, and the differences in tooth wear are likely to be at least partly due to dietary differences.

Table 4. Tooth wear in the Maori dog.

SITE	RATE OF TOOTH WEAR 0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Archaic South										
Heaphy River	1									
Kaikais Beach	3	3	2	3	3			1	1	1
Marfells Beach	5	3	1	5	1	1				
Pleasant River	1	5	1	2		2		1	3	1
Tai Rua			2	1						
Wairau Bar	1	12	3	7		2		1		
Classic South										
Long Beach	1	3	1	1	1		1			4
Murdering Beach		2		1	1	2	1		1	8
Archaic North										
Houhora	2	2		1	1	3	1	2		
Whangamata	2	1	1	1	1	2				
Classic North										
Houhora		1		2	1		1	1		

Another abnormality in dentition relating to diet which was particularly common in dogs of the South Island was the loss of a tooth during life, with subsequent ossification of the alveolus. This was due in one case to periodontal disease; otherwise it was probably due to trauma (accidental injury). Table 5 shows the distribution of jaws with premortem tooth loss, and the teeth involved.

Table 5. Premortem tooth loss in the Maori dog.

SITE	JAW	TOOTH LOST
Archaic South		
Akatore	Left mandible	P_4
Pahia	Left mandible	P_4
Shag River	Left mandible	P_1
	Left mandible	P_4*
Wairau Bar	Left mandible	Canine
	Right mandible	Canine
Classic South		
Karitane	Right maxilla	I^1
	Left mandible	P_1
Archaic North		
Opito	Right mandible	P_4

* Due to periodontal disease, see Table 3

Tooth loss during life was found in lower rather than upper jaws and was more common, according to both absolute number and percentage of the number of mandibles in each major grouping, in South Island than in North Island sites (Table 6), although in no site was it common.

Table 6. Relative incidence of premortem tooth loss.

SITE	NUMBER OF MANDIBLES WITH TOOTH LOSS	PERCENTAGE OF TOTAL NUMBER OF MANDIBLES
Archaic South	6	3.4%
Classic South	1	2.0%
Archaic North	1	1.0%
Classic North	0	0.0%

It can be seen that the only teeth lost before death are those in the anterior part of the jaw — the incisors, canines and premolars. Whereas molars are used for grinding down food, the anterior teeth are used for tearing or shearing food off (St. Clair & Jones 1957). The latter are, therefore, especially subject to accidental injury, and the presence of such injuries could be related to a hard resistant diet, such as bones.

The small number of jaws involved would make generalisations based on premortem tooth loss absurd. However, the evidence supports the other indications of dietary differences between the dogs of the North and South Islands; that the dogs of the North Island, during both Archaic and Classic Phases, ate a larger proportion of soft vegetable foods than those of the South Island. That this was not an exclusive dependence, however, is indicated both from the wide range of fauna in the middens of both periods (eaten by the Maori, and presumably therefore also by his dog) and by the almost complete absence of dental caries in the Polynesian dog of New Zealand.

Svihla, in the only detailed study of the dentition of the tropical Polynesian dog, found that dental caries in the dog were comparatively common during the prehistoric period in Hawaii (Svihla 1957, p. 11).

> The marked prevalence of caries in the teeth of the native Hawaiian dogs . . . may have been due to their diet, which was rich in starches and sugars. Although the digestion of starch takes place principally in the small intestine, even minute amounts lodged in the teeth may be converted by enzymatic action into sugars and thus serve as centres of corrosion and caries formation.

Caries were found in eleven of the thirty pre-European mandibles studied (37%) and in five of twenty-one upper jaws (24%). Usually more than one tooth was affected, and especially the first and second molars. Svihla (1957, p. 12) added that, with the introduction of European food animals into Hawaii, the diet of the Hawaiian people has changed, and now incorporates large amounts of pork and beef.

> This, in turn, means that the dogs now have a greater amount of meat in their diet. Perhaps this explains why the teeth of modern dog skulls in the Museum's collections have no caries.

Only two cases of caries were found in the Polynesian dogs of New Zealand. One of these, from Wairau Bar, is associated with, and is almost certainly the result of, congenital dental abnormality. The right carnassial of the affected skull is impacted into the first molar and both teeth show an abnormal pattern of wear (the surface of the molar acted as a shearing rather than as a grinding surface and has been pushed outwards by pressure from the first molar of the mandible). Extensive dental caries, involving almost half the tooth, and associated abscessing, affected the impacted carnassial (Fig. 4). The only other case of caries, found in the first and second molars of a mandible from Houhora, is not associated with congenital or pathological abnormality.

Two other cases of abscessing were found in the Maori dog, both from South Island Archaic sites. In the first case, from Shag River, involving the first molar of an upper jaw, the infection was comparatively minor. The second case, found

Fig. 4. Cranium from Wairau Bar with impacted carnassial and consequent dental caries and abscessing.

in a right mandible from Redcliffs, was much more severe and was of long standing. The mandible had a pronounced swelling on the lower edge of the horizontal ramus. Most of the teeth were still in place in the jaw; however, an X-ray revealed pronounced abscessing on both roots of the carnassial and, to a lesser extent, at the roots of the second and third premolars. That the abscess is chronic is shown not only by the swelling on the ramus, but (apparent in the X-ray) by the reactive scelerosis of the bone surrounding the infection.

CONGENITAL ABNORMALITIES

It has already been noted that one of the most characteristic features of the Maori dog is the presence of supernumerary teeth, which, although not found in all Maori dogs, does seem to be particular to them. Altogether there were found thirteen types of congenital dental abnormality, most of which were located in both upper and lower jaws. They were as follows.

Mandible

1. Double rooted P_1 (usually P_1 has a single root).

2. Absence of P_1 (only three premolars were present).

3. Presence of five premolars (P_1 and P_2 were single rooted, the remainder were normal).

4. Single rooted P_3 (usualy P_3 has two roots).

5. Single rooted P_4 (usually P_4 has two roots).

6. Fusion of the two roots of P_4 into a single tooth root (shaped like the figure 8).

7. Fusion of the two roots of M_2 into a single tooth root (shaped like the figure 8).

8. Absence of M_3. Since M_3 is the last tooth in the jaw to erupt, this is a normal feature in mandibles aged 6-7 months, and was considered a dental abnormality only when accompanied by pronounced tooth wear.

9.i) Double rooted M_3 (usually M_3 has a single root).

ii) Presence of small single rooted M_4.

Since in most cases the teeth had fallen out after death leaving empty alveoli it was often difficult to distinguish between these two features; they were therefore treated as one.

10. Impacted P_1 (in all observed cases with the tooth angled towards the canine).

Cranium

1. Double rooted P^1 (usually P^1 has a single root).

2. Absence of P^1.

3. Presence of five premolars (first two premolars are single rooted, the remainder are normal).

4. Presence of small single rooted premolar between P^3 and P^4 (very rare).

5. Impacted P^1 (with the tooth angled toward the canine).

6. Impacted P^2 (in all observed cases with the tooth impacted towards the molars).

7. Impacted P^4.

Tables 7 and 8 show the incidence of dental abnormalities in the various sites of the North and South Islands. It can be seen that supernumerary alveoli are by far the most common form of dental abnormality, and that these were usually found at either end of the series of cheek teeth, and in particular behind the last molar.

It is evident that abnormalities in the mandible were greater in both number and extent than those in the upper jaws. The proportion of mandibles with supernumerary alveoli, compared with the total number of mandibles, in the different groups of sites, was as follows.

Archaic South	17[1]	(0.9%)
Classic South	8	(17%)
Archaic North	8	(7%)
Classic North	2	(13%)

[1] One Marfells Beach mandible had both additional molar and premolar.

Table 7. Congenital dental abnormalities in Maori dog mandibles.

SITE	TYPE OF ABNORMALITY (see key below) 1	2	3	4	5	6	7	8	9	10
Archaic South										
Marfells Beach	2 (10%)						1 (5%)	1 (5%)	2 (10%)	
Moncks Cave							2 (33%)			
Moa Bone Pt. Cave									1 (10%)	
Redcliffs							2 (25%)		3 (38%)	
Native Island									1 (50%)	
Pleasant River									2 (13%)	
Shag River	1 (4%)						1 (4%)	2 (8%)	1 (4%)	1 (4%)
Tai Rua	1 (6%)									
Wairau Bar			2 (10%)						2 (10%)	2 (10%)
Classic South										
Jacksons Bay									3 (43%)	
Long Beach						1 (6%)	2 (13%)	1 (6%)	3 (19%)	
Houhoupounamu									1 (20%)	
Murdering Beach							1 (17%)		1 (17%)	
Archaic North										
Houhora	1 (3%)			1 (3%)					2 (5%)	
Whangamata					1 (2%)		1 (2%)		2 (5%)	
Sarahs Gully	1 (50%)									
Sunde Site							1 (50%)			
Classic North										
Houhora									2 (12%)	

KEY

1. Supernumerary P_1 tooth root
2. Absence of P_1
3. Supernumerary single rooted premolar
4. Single rooted P_3
5. Single rooted P_4
6. Root fusion P_4
7. Root fusion M_2
8. Absence of M_3
9. Supernumerary M_3 tooth root
10. Impacted P_1

Table 8. Congenital dental abnormalities in Maori dog crania.

SITE	TYPE OF ABNORMALITY (see key below)						
	1	2	3	4	5	6	7
Archaic South							
Kaikais Beach	1 (25%)						
Old Neck		1 (17%)	1 (17%)				
Native Island	1 (50%)						
Shag River	2 (25%)			2 (25%)			
Wairau Bar						1 (8%)	1 (8%)
Classic South							
Long Beach	1 (17%)						
Murdering Beach	1 (7%)						
Archaic North							
Houhora	1 (4%)						
Tairua					1 (50%)		
Sunde Site	1 (100%)						

KEY

1. Supernumerary alveolus (P^1)
2. Absence of P^1
3. Supernumerary premolar (single root)
4. Supernumerary alveolus (between P^3 and P^4)
5. Impacted P^1
6. Impacted P^2
7. Impacted P^3

There is apparently a higher incidence of congenital dental abnormality in mandibles from Classic sites, although this tendency is not seen in dental abnormalities in the crania.

An interesting fact emerges, however, if we compare the percentage of dental abnormalities in each site with the overall percentage. Where jaws with supernumerary alveoli are present in a site, they are present in relatively high proportions: in nearly every case over 30% of the mandibles are abnormal, and the proportion may reach 60% (e.g. at the Redcliffs site). The low overall proportions are due to the fact that congenital dental abnormalities are completely absent from most sites.

The reason for this is obvious: such characteristics are inherited, and if the progenitor of a population of dogs included in its dentition a dental abnormality, this would be likely to be seen in its descendants. This would not be true if the characteristic were unfavourable, but supernumerary teeth in the Maori dog were not associated with tooth crowding or infection which would result in an impaired bite and hence reduce chances of survival.

If the distribution of sites with mandibles possessing a supernumerary M_3 alveolus, the most common abnormality, is studied, it is found that they tend to fall into clusters isolated in both time and space (Figs. 1-2). The Archaic sites of Wairau Bar and Marfells Beach possess this feature; the nearby Classic site of Mussel Point does not. Similarly it is present in the Classic sites of Murdering Beach and Long Beach, but missing in the group of Archaic sites in the south.

It has been indicated in both ethnographic and archaeological evidence that the Maori engaged in seasonal cycles of activity involving transhumance within a limited locality (e.g. Firth 1959; Green 1963; Shawcross 1967). Obviously this movement would also involve dogs and it would, therefore, be expected that a characteristic abnormality would not be confined to a single site, but distributed among an associated cluster of sites. Because of the lack of detailed time control, contiguous sites cannot definitely be established as contemporaneous and their association with Archaic or Classic traits simply limits them to an approximate 500-year period. Thus a definite economic relationship, between sites within the cluster where a specific dental abnormality occurs, cannot be shown. It can be stated, however, that the presence of such an abnormality in the dog skeletal remains of two contiguous sites implies some sort of economic relationship, while its presence in one site but absence in the other would make such a relationship unlikely.

Conclusions

A study of the dentition of the Maori dog provided two types of information — firstly descriptive, how a Maori dog may be recognised and distinguished from other breeds; and secondly, indirect evidence on Maori economy as a whole. Thus the distribution of dental abnormalities into clusters isolated both spatially and temporally would seem to imply some kind of economic relationship among these sites. Of great importance is the fact that although there are significant differences in dentition (tooth wear, incidence of periodontal disease and premortem tooth loss) between North and South Island sites, there are no such differences between Archaic and Classic sites in the North Island. The evidence would seem to indicate that dogs of the North Island, during both Archaic and Classic Phases, included an appreciable amount of vegetable food in their diet. Since the Maori dog presumably shared the diet of its master, it would seem that some dependence on vegetable foods was not unique to the North Island Classic economy, but was a feature also of the Archaic Phase.

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